Orthovoltage Therapy

Is There Still a Need For It?

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• **Since there has been no significant increase in cancer cure rates in recent years that can be attributed to the treatment method alone, new and more radical procedures have been introduced in an effort to improve the results. In radiation therapy this has taken the form of supervoltage generators and in the use of high energy sources of radiation such as Cobalt 60 and Cesium 137. As this trend gains momentum, the place and future of orthovoltage therapeutic radiation (250 to 400 kilovolts) must be considered. General agreement is that supervoltage radiation offers an increase in depth dose and fewer local and systemic reactions, but it is too early to assess any change in cure rate. Measured against this is the danger of deep tissue damage, less relative biological efficiency and increased costs.**

In view of our ignorance regarding cancer, abandoning proved procedures prematurely is unjustified. The most promising trend lies in improved training and in the skillful use of what we have. While it may be that radiation of higher voltages will improve the morbidity and mortality rates, it would be better to concentrate these new modalities in centers where large numbers of cases are available.

THE DESTRUCTION of cancer by either surgical or radiological methods will remain the only successful forms of therapy for the foreseeable future. Since there has been no significant increase in cancer cure rates in recent years that can be attributed to the treatment method alone, new and more radical procedures have been introduced in an effort to improve the results. In radiation therapy, one of the most striking advances has been the great increase in the availability and use of x-ray and gamma rays at more than 1 megavolt. For this we have the resonant transformer, the Van de Graaf generator, the linear accelerator, the betatron, the synchrotron and high energy sources such as Cobalt 60 and Cesium 137. As this trend gains momentum, the place and future of orthovoltage therapeutic radiation (250-400 kilovolts) must be considered. There have been numerous articles and a few symposia on this subject, with the result that there is increasing confusion that is not limited to the nonradiologist. The purpose of this communication is to summarize the current concepts and to answer the question posed.

The fact that there is such a variety of high voltage machines should indicate that as yet the best one has not been found. It may be there will never be a best one, but that different tumor types are better treated with one form of radiation than another. It is obvious, though, that it would be technically and economically impossible for one practitioner to have all types. Each machine has its advocates, and each advocate has a more or less convincing argument for his preference.

Supervoltage radiation has been employed clinically for about 30 years. It was born in the hope of getting a beam of radiation which could deliver a high dose to a deep-seated lesion without skin damage, and of delivering a uniform dose of radiation throughout the tumor with minimal damage to surrounding normal tissues. We have reached a point where this hope has almost been achieved. The original projects, though, were abandoned. The radium bombs were dismantled. Not only were the clinical results disappointing, but the machines used were too bulky and too cumbersome for satisfactory clinical use. But they were not entirely a failure, because a vast store of information was collected and the physics of radiation in relation to dosimetry had its first real impetus. The complicated physical principles involved have now been learned, and dosimetry has been refined to a point where it hardly seems possible to refine it further. There is complete agreement that the proportion of dose that reaches the deeper structures (the so-called per cent depth dose) increases from 250 kilovolts upward, and that, as a result, smaller fields can be used; that there is less scattering with the higher voltages, which reduces the skin dose and reduces the amount of radiation outside the geometric confines of the beam; and that as a result of these factors there is less local and less system reaction. But the fulfillment of this dream is in danger of leading us only to disenchantment. The planning of therapy and the geometric configurations involved are only a small part of the total problem.

The primary consideration of all therapy is the relative radiosensitivity of the tumor, and all the admitted advantages of supervoltage do not alter

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the fact that a radioresistant tumor remains radioresistant regardless of the quality of radiation. No supervoltage apparatus will ever supplant the clinical management of a patient with cancer. The dream of the therapist is to find the means of influencing the biological response of tissues and to learn how to evaluate this response. For the most part we depend on clinical observations, and what we know we have learned by trial and error.

It becomes clear in reviewing the experiences of those who have reported their work that many investigators are confusing improved depth dose and lessened local and systemic reaction with improved statistical results, that many are influenced by whether they have supervoltage equipment, that some are interested only in the prestige value involved. The "ballyhoo" surrounding the installation of any one of the supervoltage machines is now standard procedure, including the often repeated statement that Cobalt 60 is the poor man's radium. In an environment of this type it is not strange that laymen—and many physicians—have become so impressed with supervoltage radiation that they are demanding it. The comment that withholding it from anyone may be the basis for malpractice claims, indicates the extremes this situation can reach.

To review briefly, the advantages of supervoltage over orthovoltage are: The increased depth dose, the less pronounced skin reaction, the smaller amount of normal tissue irradiated, decreased bone absorption and diminished systemic effects. However, there are certain definite and serious disadvantages and dangers. Because of the lessened skin reaction, the observation of skin reaction as a guide to therapy is no longer valid, and the possibility of overtreatment with damage to the deeper structures becomes a real hazard. A deep reaction may be substituted for a superficial one, thus losing all the potential benefits of supervoltage radiation. While the lessening of scatter results in a smaller volume of tissue being irradiated and allows for the use of a narrow beam, difficulty in determining the size or extent of the tumor, or haphazard clinical appraisal may lead to use of so narrow a beam that it does not completely encompass the lesion. All supervoltage has an increased exit dose and there is danger of producing worse reactions on the side opposite that being treated. It should be clear that high voltage radiation is a dangerous tool and can produce irreversible damage if not expertly used. Thus the poor utilization of the very characteristics which make these voltages desirable can end only in clinical failure.

Experimental evidence has indicated and clinical experience has confirmed that the relative biological effectiveness of radiation from supervoltage is less than that from 250 or 400 kilovolts. This means that in terms of practical application, in order to get the same clinical response a larger total tumor dose must be given. This usually means 7,000 to 8,000 r instead of the usual 6,000 r given with 250 kilovolts, and also a somewhat longer treatment period, which can be a limiting factor of considerable importance if the number of patients is large.

To attempt to demonstrate superiority of certain voltages statistically beclouds true progress, and it is less than realistic to compare clinical results from different institutions using different radiation sources. The futility of such observations can be illustrated by the following quotations from four leading institutions by four eminent radiologists, made during a symposium about two years ago. Cantril[1] expressed belief there was a 15 per cent increase in survival with supervoltage. Friedman[1] agreed that he had obtained a 10 per cent increase in cure rate. Guttman[1] was not certain whether or not there had been any over-all improvement, and Watson[1] was certain that there had been little if any change in survival time. It is obvious, of course, that different types of cases were involved, a different degree of selectivity and different treatment techniques. To attempt to correlate these conclusions would be difficult if not impossible, and probably meaningless.

It should be clear to everyone that supervoltage will not fulfill the optimistic expectations held out for it. Instead there is a danger that the belief that higher voltages means cure, will lead to disillusionment. We become overconfident and treat patients who should not be irradiated at all. We cannot hope to correct either the errors and failures of surgeons or of radiologists with supervoltage radiation, and we should use care in giving assurance to patients and their families that radiation with Cobalt, for example, is the universal panacea.

But while the cure rate may not be influenced by supervoltage radiation, there seems to be little doubt that there is sometimes an improvement in palliation, and that some patients are more comfortable during the course of therapy. Whether this consideration is sufficient justification for replacing existing therapy equipment or of adding supervoltage sources is the point to be decided. Is it economical or efficient to invest forty or fifty thousand dollars to treat about 10 per cent of malignant tumors, which it has been estimated make up the volume that can receive increased benefit from high voltage radiation? Although it would appear that after 30 years it should be possible to assess the value of supervoltage radiation, we are still uncertain as to the most efficient and effective type. Yet the evidence is consistent that there is some future in higher voltages, primarily because of the advantages mentioned and despite the hazards discussed. But, should it be

Cobalt 60, Cesium 137 or some form of x-ray generator?

It is apparent that a great deal of investigation is still necessary. The expense of such installations and the need for constant monitoring and maintenance makes it an unsuitable project for an individual or for small institutions. The need for further study and research and the problem of finding the best procedure for any particular lesion make it imperative that a study of this sort be carried out in centers large enough to have the volume of patients and the technical help necessary. Certainly at present the cost of equipment and lack of mobility, the expense of buildings and a shortage of trained personnel should retard the widespread use of supervoltage. At the same time, the pressures of manufacturers, hospital administrators and trustees, and sometimes the need for publicity, has resulted in the installation of numerous Cobalt units. There is real danger that these pressures and the need to justify the expenses involved may actually prevent the careful studies necessary to determine the place for this type of therapy in the field of cancer management.

The need for biological research is imperative as it becomes increasingly evident that the biological character and the extent of the disease is by far the most important factor in determining the therapeutic result. The particular radiation modality used plays a relatively minor role, while the skill, training and interest of the therapist is of major importance.

For the present, the widely used orthovoltage radiation should be continued as the backbone of radiation therapy in cancer, because there is no doubt that in competent hands the results with 250 kilovolts have been as good as any reported with supervoltage radiation. It would be unwise for any radiologist or institution, other than one prepared to assume the obligation and responsibilities associated with investigative procedures, to abandon tried and proved methods. Physicians practicing at the community level should avoid experimental procedures. What may seem valid radiation in a research center, where the large number of cases makes careful selection possible, may be quite unconscionable in other circumstances.

Our ignorance of cancer demands that we utilize what we have to the best of our ability and to stress the training of radiologists in the skillful use of the measures available.

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REFERENCE

1. Friedman, M., Cantril, S., Guttman, R. J., and Watson, T. A.: Supervoltage. Should We Junk 250 Kv. A Symposium. Radiology, 67:481-515, 1956.